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PROVISIONAL SPECIFICATION.

Improvements in or relating to Pumps.

I, RICHARD HARLAND DICKINSON, a British Subject, of 17 The Avenue, Old Windsor, Berkshire, do hereby declare the nature of this invention to be as follows:—

This invention relates to pumps for liquids and has for its object to provide an improved construction of pump suitable for lifting liquids from a depth, as for example, from a bore hole or well and delivering it at any desired height, such pumps being commonly known as deep-lift pumps.

According to this invention, the pump comprises a hydraulic pressure line extending downwards to the suction inlet from the operating element which may be a piston and cylinder, a centrifugal pump or any other device for applying pressure to the hydraulic line, and a delivery pipe extending upwards from the lower end of the pressure line to any desired height, the pressure line and the delivery pipe constituting a U-tube.

According to another feature of this invention, the connection between the pressure line and delivery pipe may be arranged to constitute an upwardly directed ejector in the delivery pipe arranged so that a suction effect is produced on the suction inlet.

According to yet another feature of this invention, there may be provided at or near the upper end of the delivery pipe, a connection from it to the upper end of the hydraulic pressure line, with a non-return valve therein permitting liquid to pass from the delivery pipe to the pressure line under the control of this valve as operated by the pressures to which it is subjected on its two sides in the delivery pipe and pressure line respectively.

According to yet another feature of this invention, the delivery pipe is of smaller cross-sectional area than the pressure line.

In one embodiment of this invention which will now be described by way of example, a pumping installation comprises a reciprocating pump constituted by a piston in a cylinder with the cylinder in free communication with a hydraulic pressure line which extends downwards from the piston to the inlet port through which liquid to be pumped is taken into the system, and this port is controlled in the usual way by a non-return valve which will admit liquid, but prevent its outward flow from the system. A delivery pipe which is preferably of smaller diameter than the pressure line aforesaid is also connected to the suction inlet, and therefore to the lower end of the pressure line so that the two pipes constitute a U-tube, and when the system is primed by filling it with liquid, the two columns of liquid balance one another so that the total depth from the piston to the suction inlet can be more than a barometric column of liquid, and the pump can operate at such depths.

When the piston is reciprocated in the cylinders, on the inward stroke pressure is applied to the pressure line so that liquid is forced down and into the delivery pipe at the lower end thereof so as to displace the liquid therein upwards. The liquid in the delivery pipe being thereby set in motion, at a higher velocity than the liquid in the pressure line, tends to continue in motion when the piston reaches the inner end of its stroke and stops, and liquid is therefore drawn in past the suction valve to maintain the pipe system filled, so that when the piston moves outwards, the hydraulic pressure line is again filled and the next stroke of the piston repeats the operation. The additional liquid which is drawn in past the suction valve is expelled through the delivery pipe on each stroke.

In a modified construction according to this invention, the pressure line may be provided at its lower end with a tapering nozzle which is upwardly directed in the delivery pipe to constitute an ejector, and delivery pipe being extended downwards past the nozzle to the inlet suction valve.

In this way a direct ejection effect is produced at the suction valve, reducing the pressure thereon in addition to the effect produced by the higher velocity of the liquid in the delivery pipe as above mentioned.

The ejector may be constituted by a tapering nozzle on the pressure line as above described, or alternatively the pressure line may open into the delivery pipe so as to provide an annular jet surrounding a pipe which is in direct communication with the suction inlet. This constitutes merely an alternative form of ejector and apparatus in the manner already described.

The hydraulic pressure line and the delivery pipe may be arranged side by side, or in an alternative construction they may be co-axial, in which case the delivery pipe is preferably arranged inside the pressure line. In one such construction the delivery pipe extends downwards to near the bottom end of the pressure line which is closed, and the suction inlet opens into a tapering pipe which extends upwards inside the delivery pipe so as to constitute an ejector operated by the flow of liquid from the pressure line into the open end of the delivery pipe around the tapering nozzle. The pump is operated by a piston in a cylinder directly connected with the upper end of the pressure line, and an air vessel may be provided in communication with the upper end of this line for absorbing excessive variations in pressure produced by the movement of the piston in the usual way. The communication with this air vessel is preferably controlled by an adjustable valve.

A port or opening in the upper end of the delivery pipe opens into the hydraulic pressure line, and is controlled by a non-return valve so that liquid can pass from the delivery pipe into the upper end of the pressure line at a point near the piston, when the piston is making its outward stroke. A priming cock is preferably provided at a suitably high point in the system to facilitate the starting of the pump.

Since the improved pump according to this invention operates by the application of pressure to the hydraulic pipe line and a downward movement of the liquid therein, it is not essential to use a piston in a cylinder which gives only intermittent pressure, and according to another feature of this invention a centrifugal pump or other device giving a constant pressure of flow downwards in the hydraulic pressure line may be used. In this case the cross connection between the upper end of the delivery pipe and the upper end of the pressure line is used, so that a small proportion of the liquid passing outwards through the delivery pipe is withdrawn and delivered to the pressure line for the purpose of maintaining the flow therein. It will also be clear that it is desirable in this construction to use the ejector connection of the suction inlet as described above.

Dated this 5th day of November, 1945.

BOULT, WADE & TENNANT,
111 & 112 Hatton Garden,
London, E.C.1,
Chartered Patent Agents.

COMPLETE SPECIFICATION.

Improvements in or relating to Pumps.

I, RICHARD HARLAND DICKINSON, a British Subject, of 17 The Avenue, Old Windsor, Berkshire, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to pumps for liquids and has for its object to provide an improved construction of pump particularly, although not solely, suitable for lifting liquids from a depth, as for example, from a bore hole or well and delivering it at any desired height, such pumps being commonly known as deep-lift pumps.

According to this invention there is provided in a pump, the combination with a hydraulic pressure-line extending downwards, a delivery pipe extending upwards from the lower end of the pressure-line to constitute a U-tube, an inlet-pipe connected at or near the lower end of said pressure-line and delivery-pipe, and a non-return inlet-valve in the inlet-pipe; of a device, such as a piston and cylinder, arranged to oscillate a column of liquid in the hydraulic pressure-line.

According to another feature of this invention, the connection between the pressure-line and delivery-pipe may be arranged to constitute an upwardly directed ejector in the delivery pipe arranged so that a suction effect is produced on the suction-inlet.

It has previously been proposed to use an upwardly directed ejector at the bottom of the discharge tube of a pump

but it has not been proposed to supply such an ejector from a piston and cylinder pressure producing device.

According to yet another feature of this invention, there may be provided on the delivery-pipe, a connection from it to the upper end of the hydraulic pressure-line; a non-return valve may be provided therein permitting liquid to pass from the delivery-pipe to the pressure-line under the control of this valve as operated by the pressures to which it is subjected on its two sides in the delivery-pipe and pressure-line respectively.

According to yet another feature of this invention, the delivery-pipe may be of smaller cross-sectional area than the pressure-line.

Other features of the invention will be described with reference to various embodiments of the invention which are illustrated in the accompanying diagrammatic drawings. In these drawings: Figure 1 represents a simple form of pump according to this invention.

Figure 2 is a part view showing a modified construction.

Figures 3, 4 and 5 are diagrams showing various modified constructions, and

Referring first to Figure 1 a pumping installation comprises a piston 10 driven by any suitable motor 11 and working in a cylinder 12 which is in free communication with a hydraulic pressure-line 13 which extends downwards from the cylinder 12 to the point from which liquid is to be pumped. At its lower end 14 the pressure-line communicates with a delivery-pipe 15 which extends upwards to any desired height to which the liquid is to be delivered. The pressure-line 13 and the delivery pipe 15 can thus constitute a U-tube in which the static pressures of two columns can balance one another according to their respective heights.

At the lower end of this U-tube there is a suction-inlet pipe 16 communicating with a valve-chamber 17 in which a non-return valve 18 permits entry of the liquid to be pumped, into the system, but prevents outward flow therefrom. The delivery-pipe 15 is shown as terminating at an outlet 19 which may be at any desired height or location with respect to the piston 10.

The cross-sectional area of the delivery pipe 15 is preferably smaller than that of the pressure line 13.

In the operation of this pump the system is primed by filling it with liquid in any convenient manner, when the piston 10 is reciprocated in the cylinder, the liquid in the pressure line is oscillated and on the downward or inward stroke, pressure is applied to the pressure-line so that the liquid is forced down and into the delivery-pipe at the lower end thereof so as to displace the liquid in the delivery-pipe upwards.

The liquid in the delivery-pipe being thereby set in motion, at a higher velocity than the liquid in the pressure-line when the delivery-pipe is smaller than the pressure-line, tends to continue in motion when the piston reaches the inner end of its stroke and stops. This continued motion of the liquid in the delivery pipe draws in more liquid past the suction-valve 18 to maintain the pipe-system filled, so that when the piston moves outwards on its return stroke the pressure-line is also filled the next stroke of the piston repeats the operation, and the additional liquid which is drawn in past the suction-valve 18 is expelled through the delivery-pipe on each stroke.

In the modification illustrated in Figure 2 there may be provided between the delivery-pipe 15 and the pressure-pipe 13 a cross-connection 20 near the upper ends of the pipes; this cross-connection is situated at a point near the outward limit of movement of the piston 10 so that it is uncovered as the piston reaches the end of its outward stroke and liquid can flow in from the delivery-pipe into the pressure-line to ensure it being filled ready for the next stroke.

Figure 2 also shows another modification in which a non-return valve 21 is provided in the pressure-line near the lower end thereof, this valve being held in its closed position by a spring 22 so as to support to any desired extent the column of liquid above it, whilst permitting free downward flow on the inward stroke of the piston. Since this valve prevents upward flow into the pressure-line, this line is refilled at the end of the outward stroke of the piston 10 through the cross-connection 20.

Figure 3 illustrates a modified construction of pump in which the piston 10 operates in a cylinder 12, but the pressure-line 13 is not necessarily of the same diameter as the cylinder 12. The lower end of the pressure-line 13 is connected as before at 14 with the delivery-pipe 15, but the valve-chamber 17 opens by an inlet-pipe 23 into the delivery-pipe at a point spaced upwards from the junction 14 with the pressure-line. The delivery-pipe may be tapered immediately above the upper end of the pipe 23 to constitute an ejector which is operated by the flow of liquid from the pressure-line 13 upwards in the delivery-pipe 15 past the open end of the pipe 23. In this way a direct ejection effect is produced at the suction-valve 18 reducing the pressure thereon, in addition to the effect produced by the higher veloc-

ity of the liquid in the pipe 15 as above mentioned; in this way a greater quantity of liquid can be drawn in at each stroke of the pump.

In Figure 4 a slightly different construction is illustrated in which the piston 24 and cylinder 25 are arranged at right-angles to the pressure-line 13 instead of being aligned therewith. An upward extension of the pressure-line 13, shown at 26, is provided with a priming-valve 27. In this drawing there is also shown a modified construction of ejector, in which the lower end of the pressure-line 13 is bent upwards and tapered at 28 to constitute an ejector-nozzle 29 operating in a tapered part of the delivery-pipe 15, in this case the valve chamber and inlet-pipe 30 is constituted by the lower end of the delivery-pipe 15, and the inlet-suction-valve 18 is similar to that already described.

At a point in the delivery-pipe near the cylinder 25 a cross-connection pipe 31 is provided between the delivery-pipe 15 and the pressure-line 13, and this cross-connection is provided with a non-return valve 32 which permits flow from the delivery-pipe into the pressure-line 13 and cylinder 25 according to the pressure-difference existing across the valve so that the pressure-line and cylinder are maintained full of liquid at all times.

In all the constructions so far described the pressure-line and delivery-pipe have been illustrated as side by side but in an alternative construction illustrated in Figure 5 they may be co-axial. The pressure-applying device in the system is shown as a piston 10 similar to that already described, but the pressure-line 33 is made of a diameter sufficiently large to accommodate within it the delivery-pipe 34, and the delivery-pipe as already described may be of less cross-sectional area than the annular cross-sectional area of the pressure-line 33. The ejector-action on the suction-inlet-valve 35 is provided by a tapering inlet-pipe 36 extending upwards from it into the delivery-pipe 34 and the lower end of the delivery-pipe is open at 37 to the pressure-line 33 so that the operation of this pump is similar to those already described. Communication may be provided under the control of a non-return valve 38 between the delivery-pipe and the pressure-line 33 and cylinder 12.

There may also be provided in connection with the pressure-line 33 the usual type of air-reservoir 39 for equalizing the variations in pressure produced by a reciprocating pump, and it is a feature of the present arrangement that the communication between the pressure-line 33 and the reservoir 39 is controlled by a manually adjustable valve 40 to suit any particular conditions of operation.

The priming valve 41 may be provided at the upper end of the delivery-pipe.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In a pump, the combination with a hydraulic pressure-line extending downwards, a delivery pipe extending upwards from the lower end of the pressure-line to constitute a U-tube, an inlet-pipe connected at or near the lower end of said pressure-line and delivery-pipe, and a non-return inlet-valve in the inlet-pipe; of a device, such as a piston and cylinder, arranged to oscillate a column of liquid in the hydraulic pressure-line.

2. A pump according to claim 1 wherein the connection between the pressure-line and the delivery-pipe is arranged to constitute an upwardly directed ejector in the delivery-pipe so that a suction effect is produced on the inlet-valve.

3. A pump according to claim 1 or claim 2 wherein the cross-sectional area of the delivery-pipe is less than that of the pressure-line.

4. In a pump according to any of the preceding claims the combination with the delivery-pipe, of a cross-connection from it to the upper end of the hydraulic pressure-line.

5. A pump according to claim 4 wherein a non-return valve in the cross-connection permits flow only from the delivery-pipe to the pressure-line.

6. A pump according to claim 4 wherein the cross-connection is controlled by the piston which also constitutes the pressure-applying device of the pump.

7. In a pump according to claim 1 the combination with a piston reciprocating in a cylinder open to the hydraulic pressure-line, of an air-vessel or reservoir communicating with said line, and an adjustable valve controlling said communication.

8. The improved construction and arrangement of pump substantially as described and illustrated in the accompanying drawings.

Dated this 15th day of November, 1946.

BOULT, WADE & TENNANT,
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London, E.C.1,
Chartered Patent Agents.

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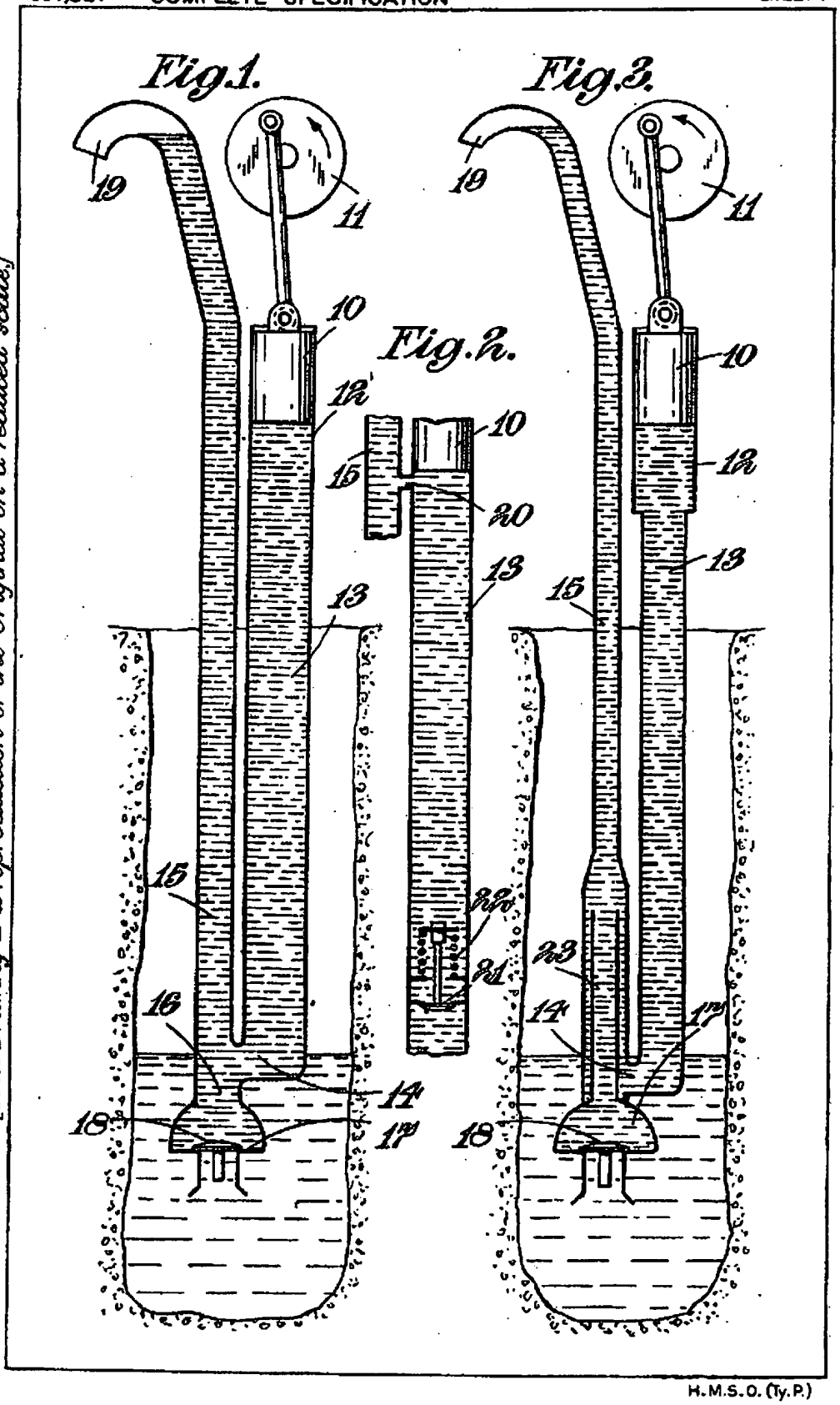

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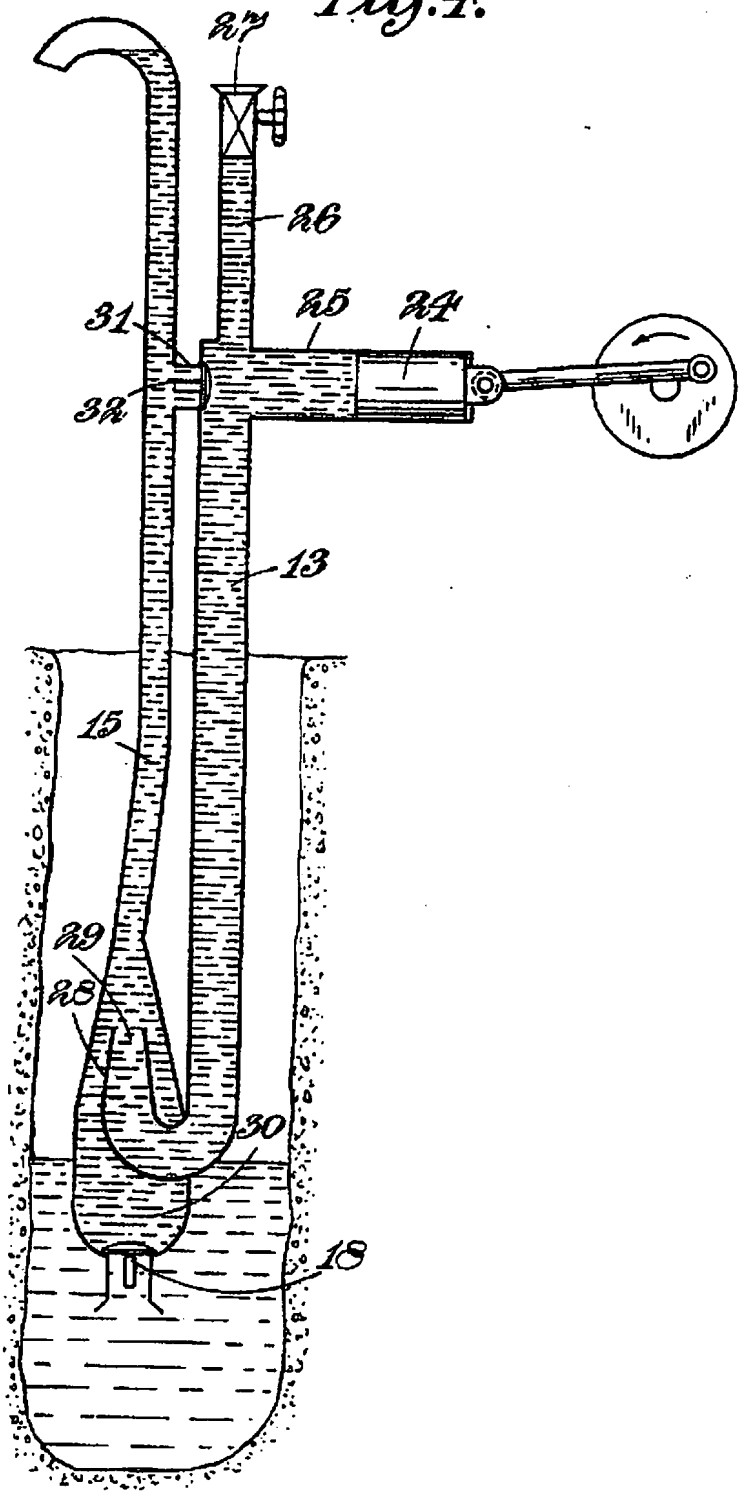
H.M.S.O. (Ty.P.)

Fig.4.



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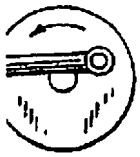


Fig.5.

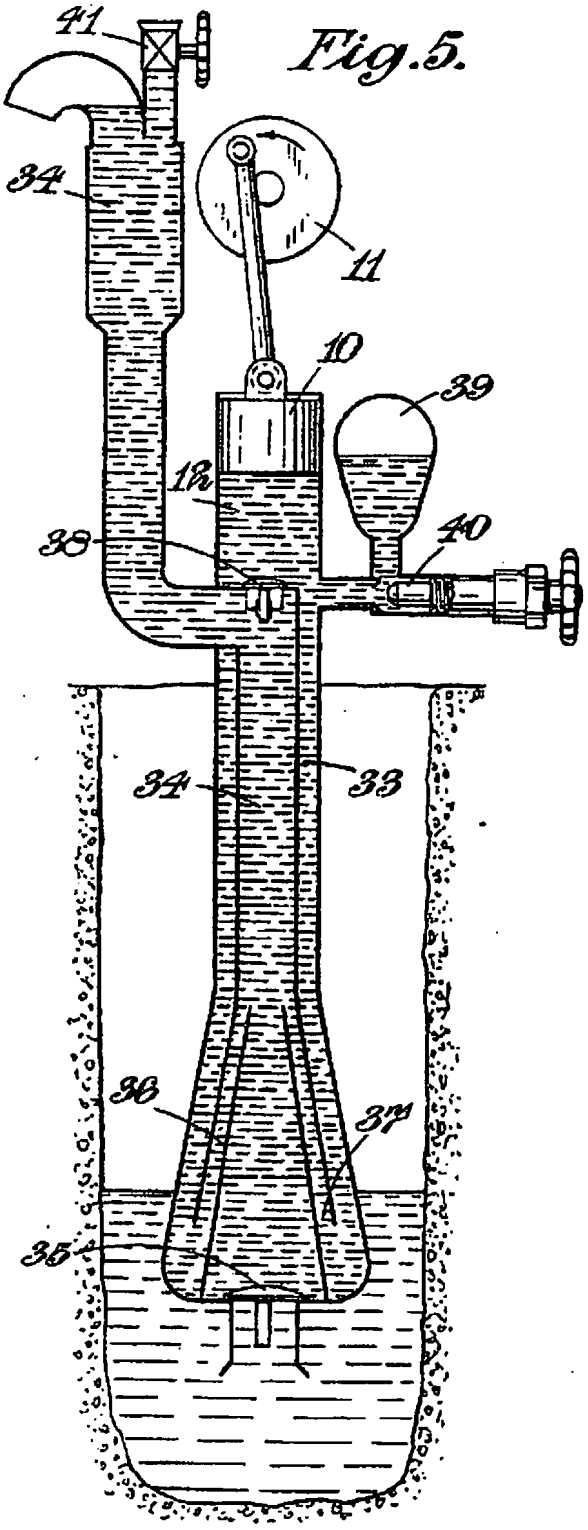


Fig. 4.

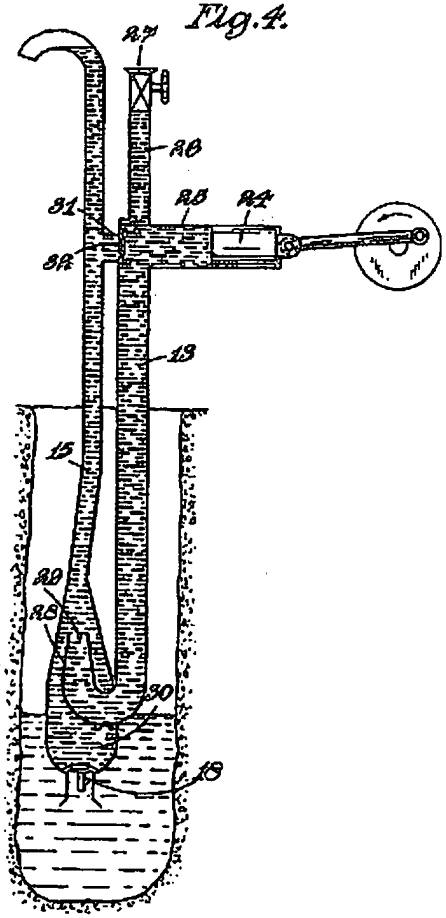
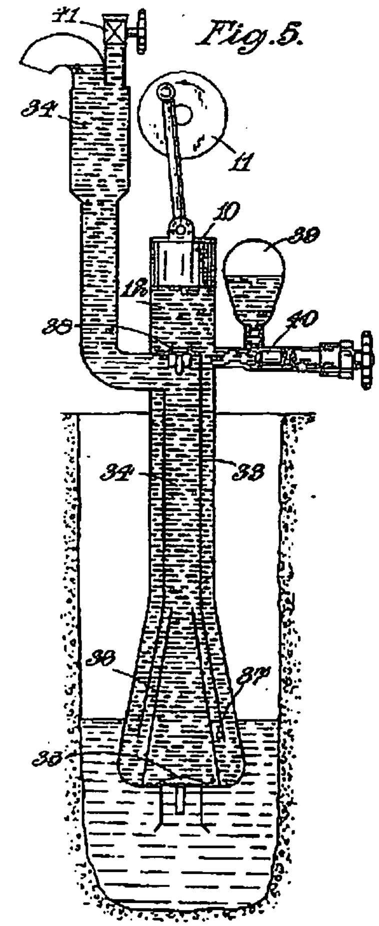


Fig. 5.



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